Smart Sensors

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Introduction

We can have integrated sensors which has electronics and the transduction element together on one silicon chip. This complete system can be called as system-on-chip (SoC).

The main aim of integrating the electronics and the sensor is to make an intelligent sensor, which can be called as smart sensor. Smart sensors then have the ability to make some decision.

Physically a smart sensor consists of transduction element, signal conditioning electronic and controller/processor that support some intelligence in a single package.

Definition

A smart sensor is an analog /digital transducer combined with a processing unit and a communication interface.

Smart sensors / Intelligent sensor are sensors with integrated electronics that can perform one or more of the following function

- Data Conversion
- Bidirectional communication,
- Take decisions.
- Perform logical operations

Functional Units

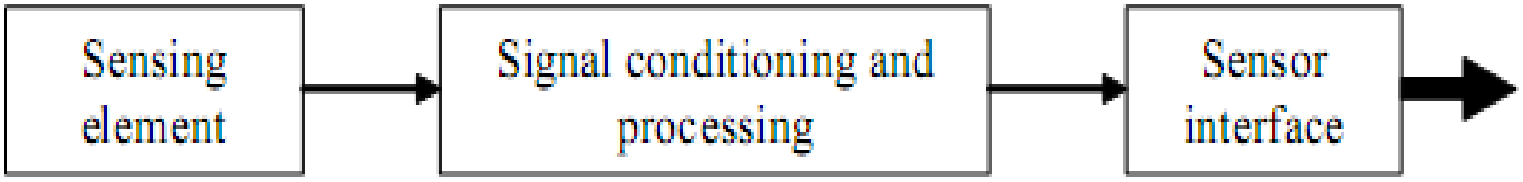


Figure 3. Traditional Integrated Sensors.

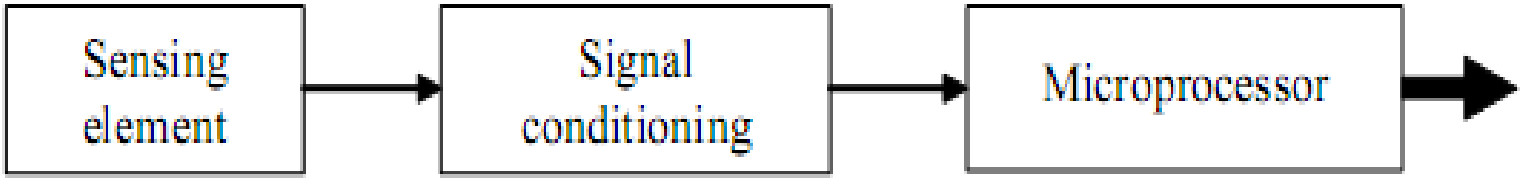
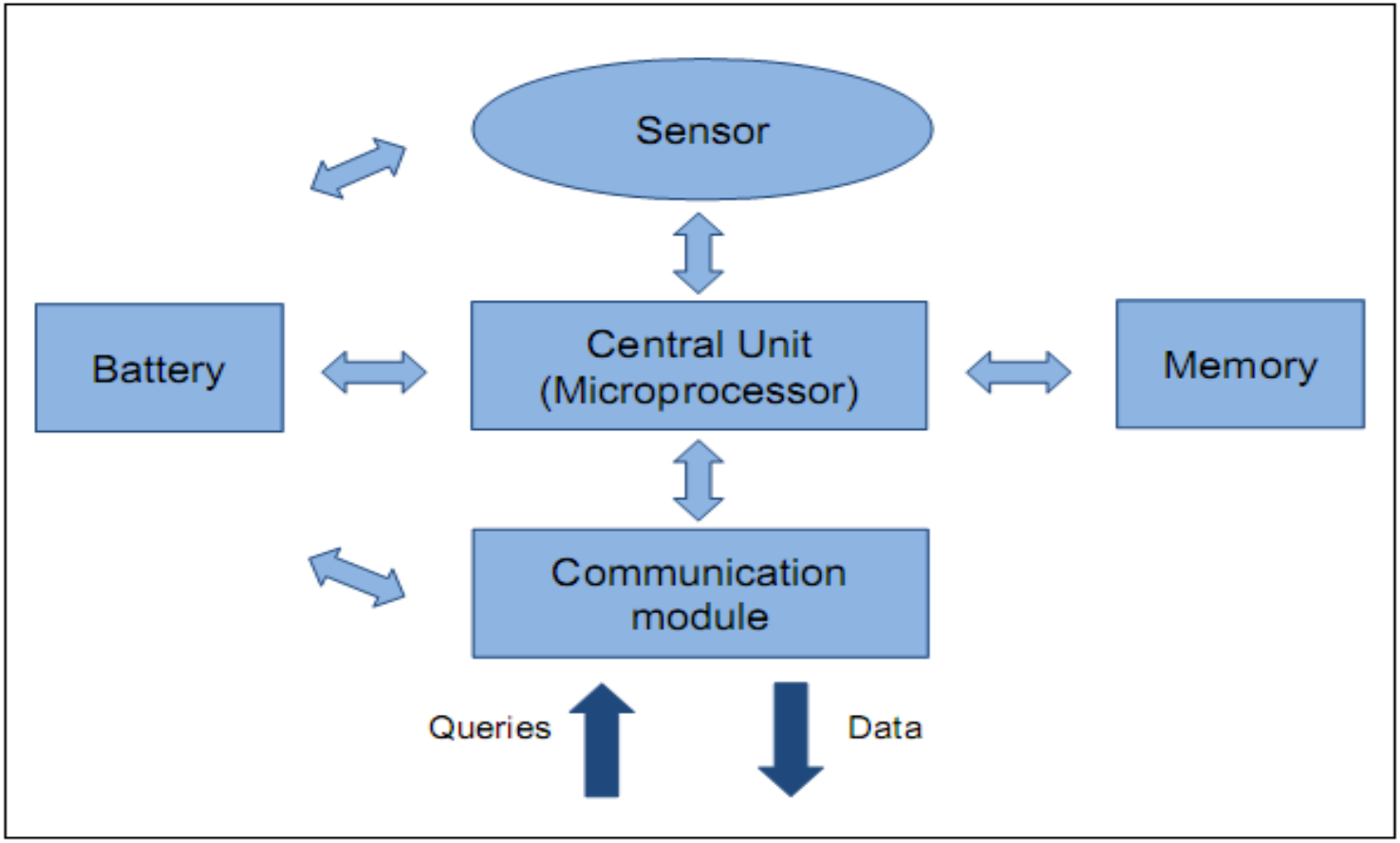
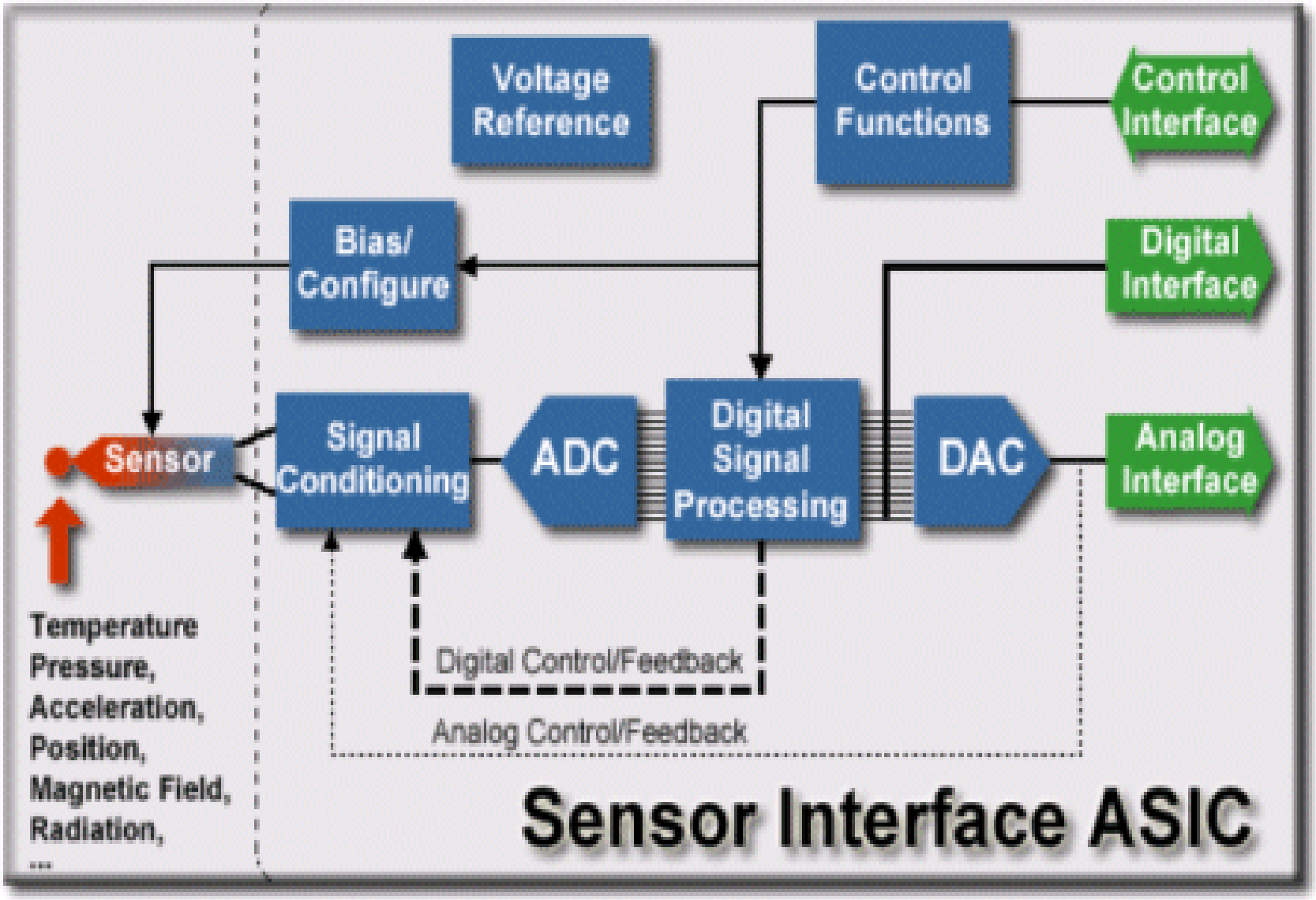


Figure 4. Smart Sensor.

Architecture

Figure 2: Architecture of a sensor node




Voltage Reference
Control Functions
Control Interface
Bias/ Configure
Digital Interface
Sensor
Signal Conditioning
ADC
Digital Signal Processing
DAC
Analog Interface
Temperature
Pressure,
Acceleration,
Position,
Magnetic Field,
Radiation,
...
Digital Control/Feedback
Analog Control/Feedback
Sensor Interface ASIC

Peripheral Interface

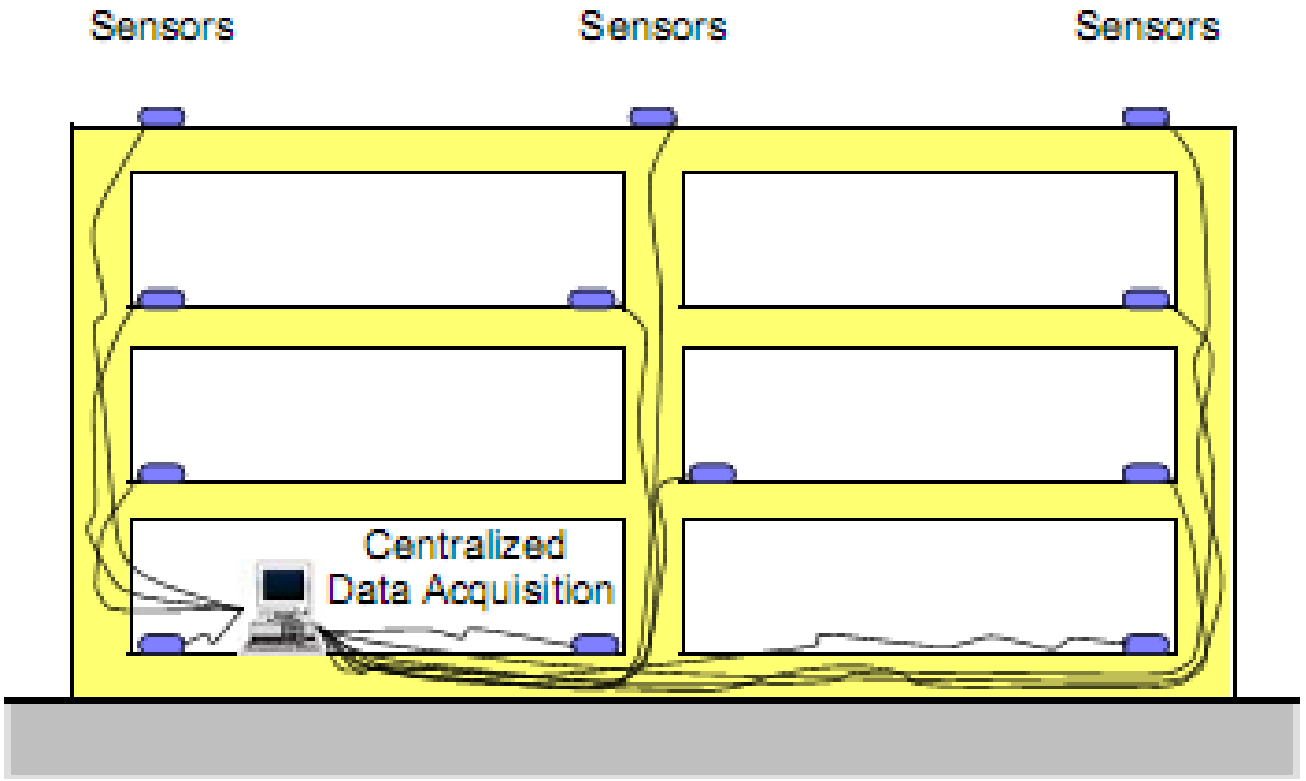
- RS232
- I2C
- CAN
- LIN
- UART
- MAC
- Ethernet
- Timer
- Interrupt
- ADC
- DAC
- RAM
- ROM
- RFID

Table 1: Examples of sensor types and their outputs

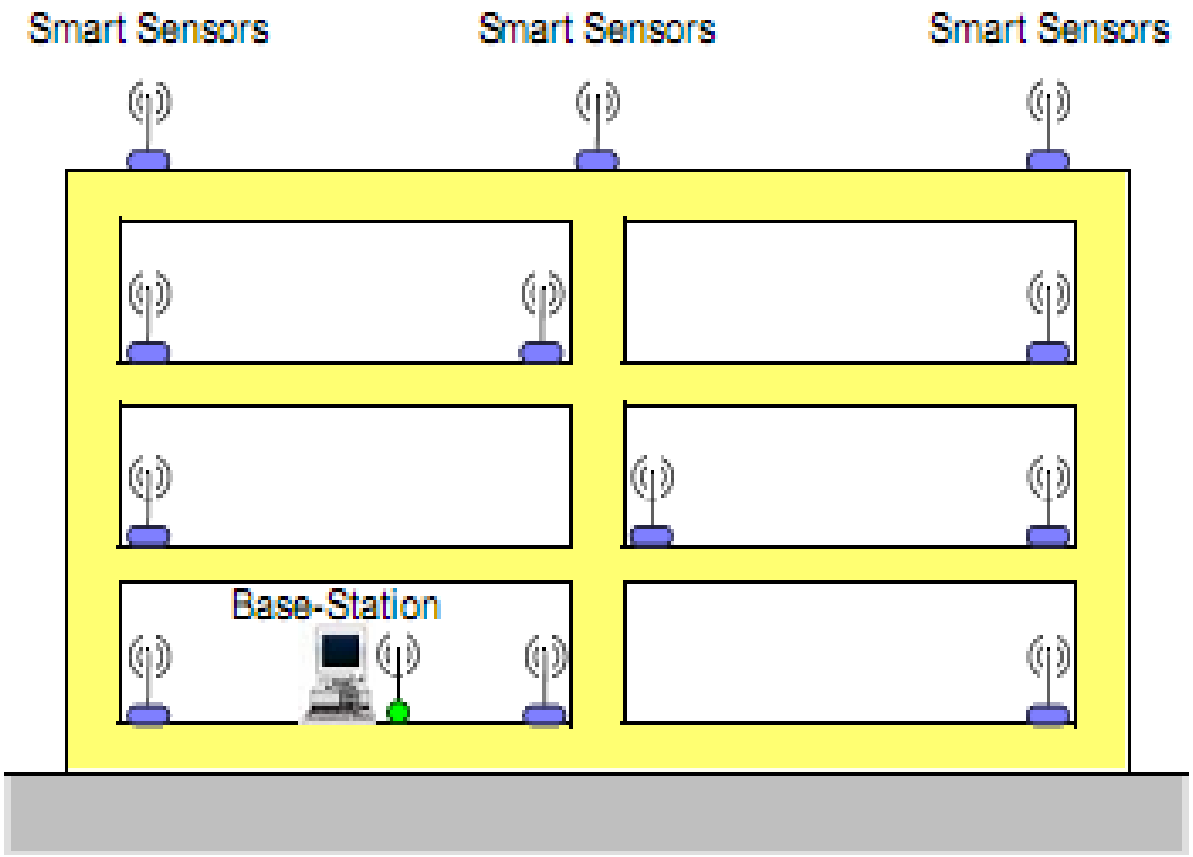
Physical property	Sensor	Output
Temperature	Thermocouple	Voltage
	Silicon	Voltage/Current
	Resistance temperature detector (RTD)	Resistance
	Thermistor	Resistance
Force/Pressure	Strain Gauge	Resistance
	Piezoelectric	Voltage
Acceleration	Accelerometer	Capacitance
Flow	Transducer	Voltage
	Transmitter	Voltage/Current
Position	Linear Variable Differential Transformers (LVDT)	AC Voltage
Light Intensity	Photodiode	Current

Source: OECD based on Wilson, 2008.

Wired Sensor Network

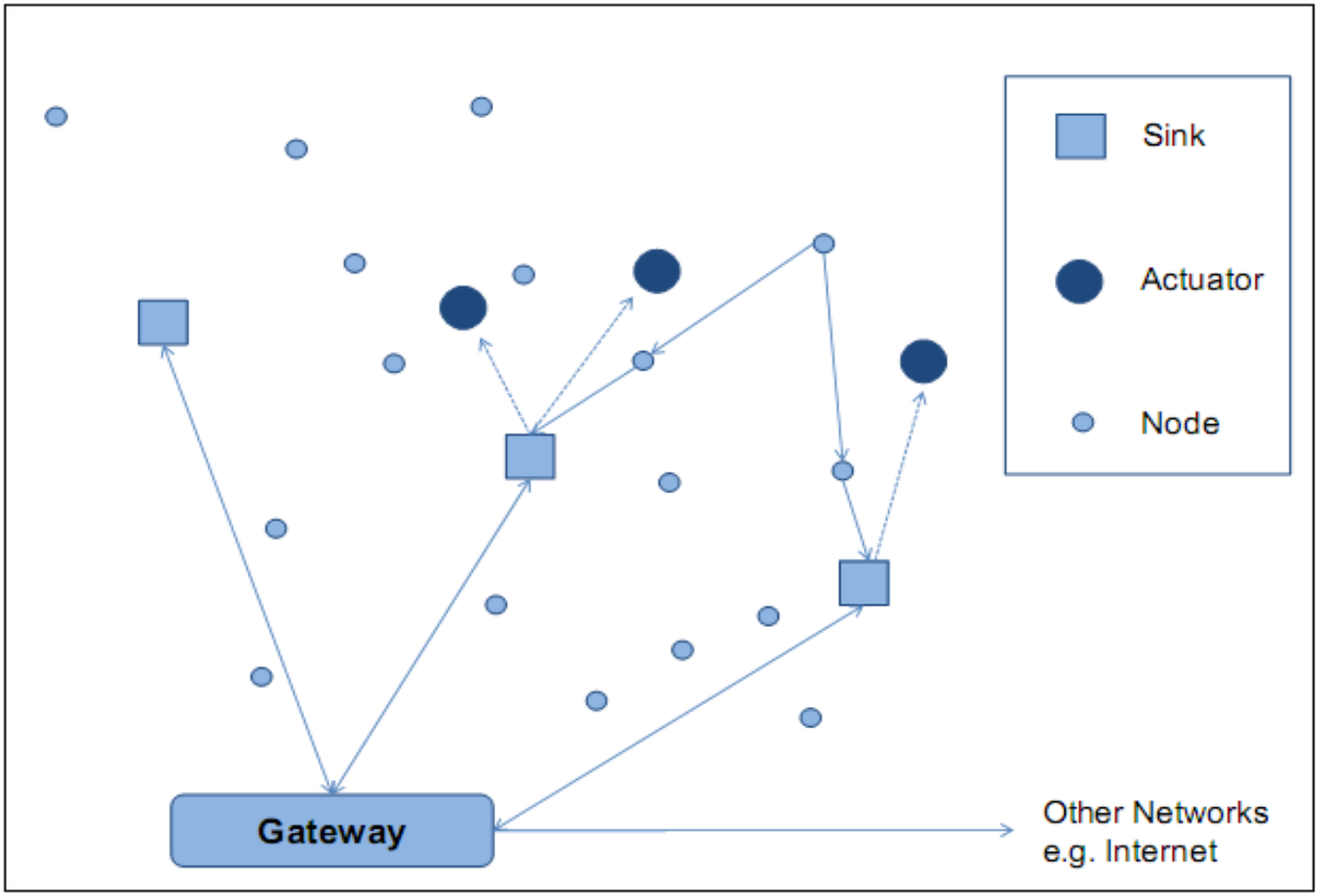


Wireless Sensor Network



WSN

Figure 1: Typical wireless sensor and actuator network



Advantages

- Acquire the measurement (DAS)
- Provide signal conditioning
- Converts measurement into a unit
- Transmit the information wirelessly
- Ease of installation (P&P Device)
- Simplify design of system
- Allow the external interface devices
- Low cost, low power & Small Size

Transducers & Outputs

Table 1: Examples of sensor types and their outputs

Physical property	Sensor	Output
Temperature	Thermocouple	Voltage
	Silicon	Voltage/Current
	Resistance temperature detector (RTD)	Resistance
	Thermistor	Resistance
Force/Pressure	Strain Gauge	Resistance
	Piezoelectric	Voltage
Acceleration	Accelerometer	Capacitance
Flow	Transducer	Voltage
	Transmitter	Voltage/Current
Position	Linear Variable Differential Transformers (LVDT)	AC Voltage
Light Intensity	Photodiode	Current

Source: OECD based on Wilson, 2008.

Prototype-1

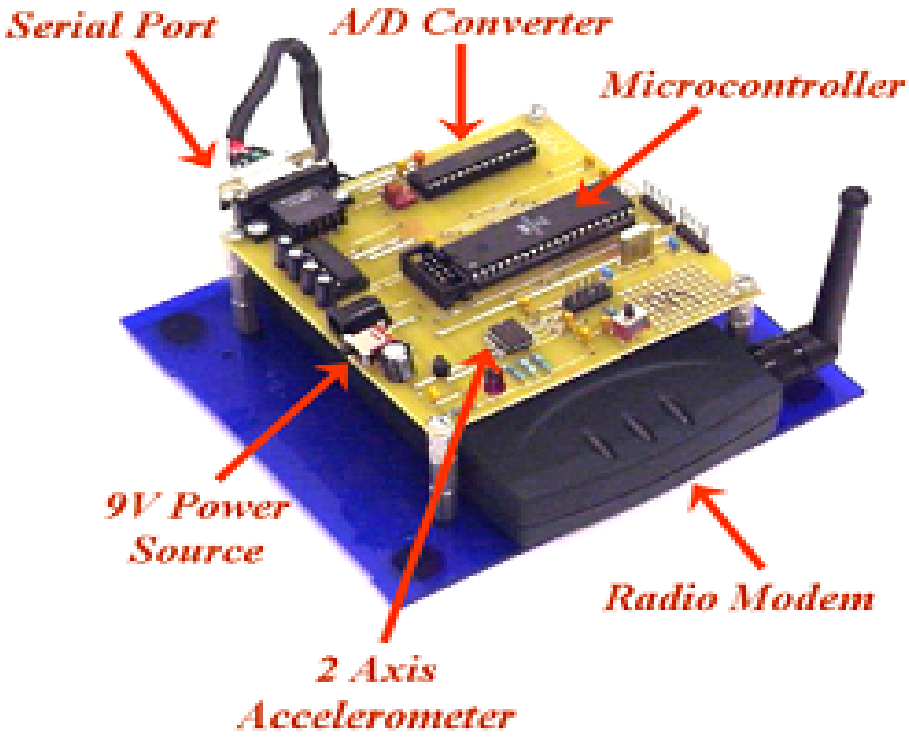


Figure 5. Prototype Smart sensor (Lynch *et al.* 2001).

Prototype-2

Figure 7. Prototype Smart sensor
(EYES project 2002).

Prototype-3

Figure 9. Intel® Mote Prototype.

Characteristics

Table 1: Characteristics of the Mica2 and Mica2dot processor boards

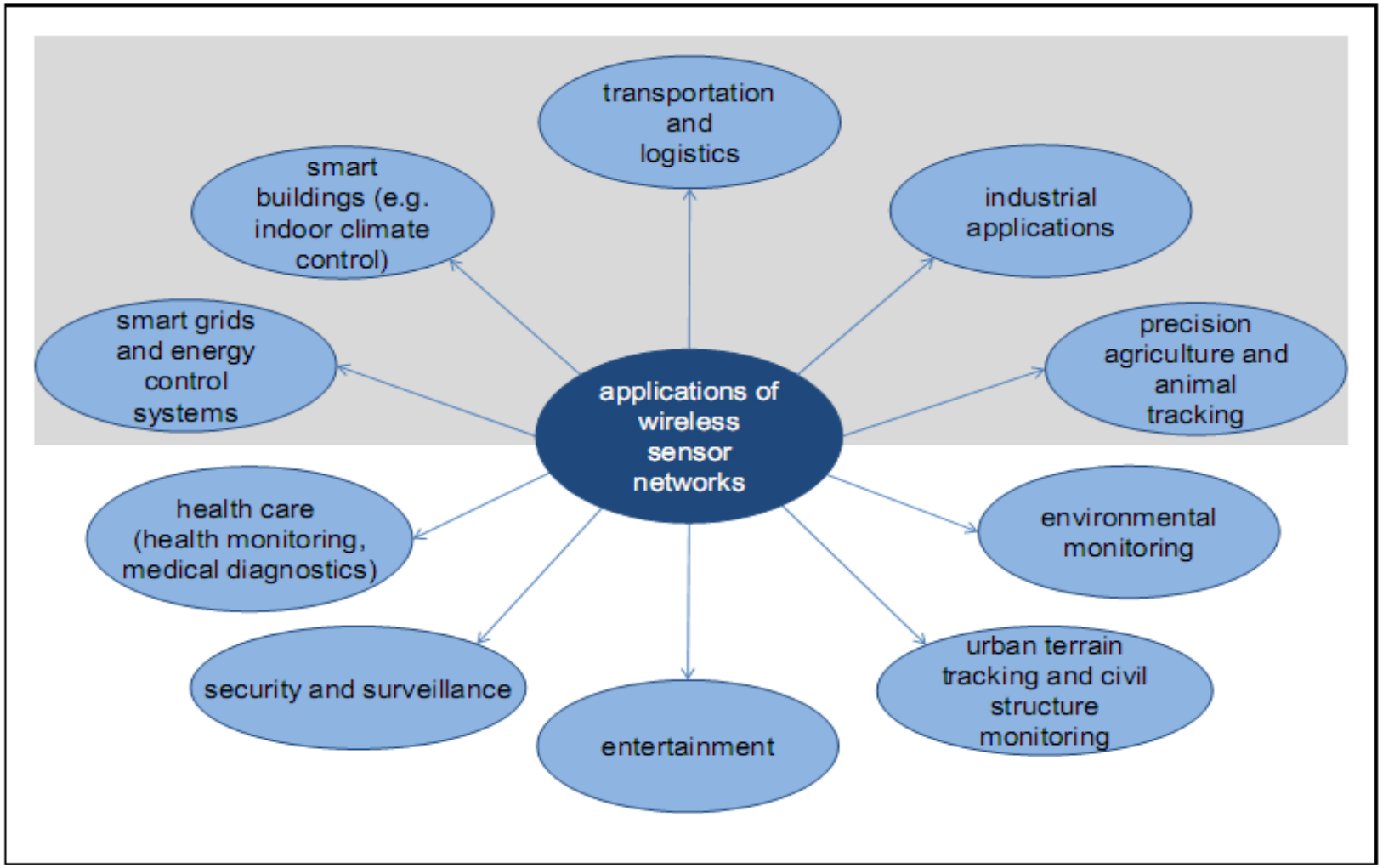
Performance	Mica2	Mica2dot
Flash memory	128K bytes	128 K bytes
Measurement memory	512K bytes	512K bytes
EEPROM	4K bytes	4K bytes
A/D (Channels)	10 bits (8)	10 bits (6)
Center Frequency	433 868/916MHz	433 868/916MHz
Num. of channels of RF	5	8
Data rate	38.4 K baud	38.4 K baud
Outdoor range	300 m.	300 m.

Table 2: Characteristics of the Intel® Mote Prototype

Performance	Intel® Mote Prototype
Programming memory	64K bytes
Measurement memory	512K bytes
Processor	32 bits (12 MHz)
Center Frequency	2.4 GHz
Data rate	723.2/57.6 K baud
Outdoor range	30 m.
Size	3 x 3 cm

Applications

Figure 3: Fields of application of wireless sensor networks

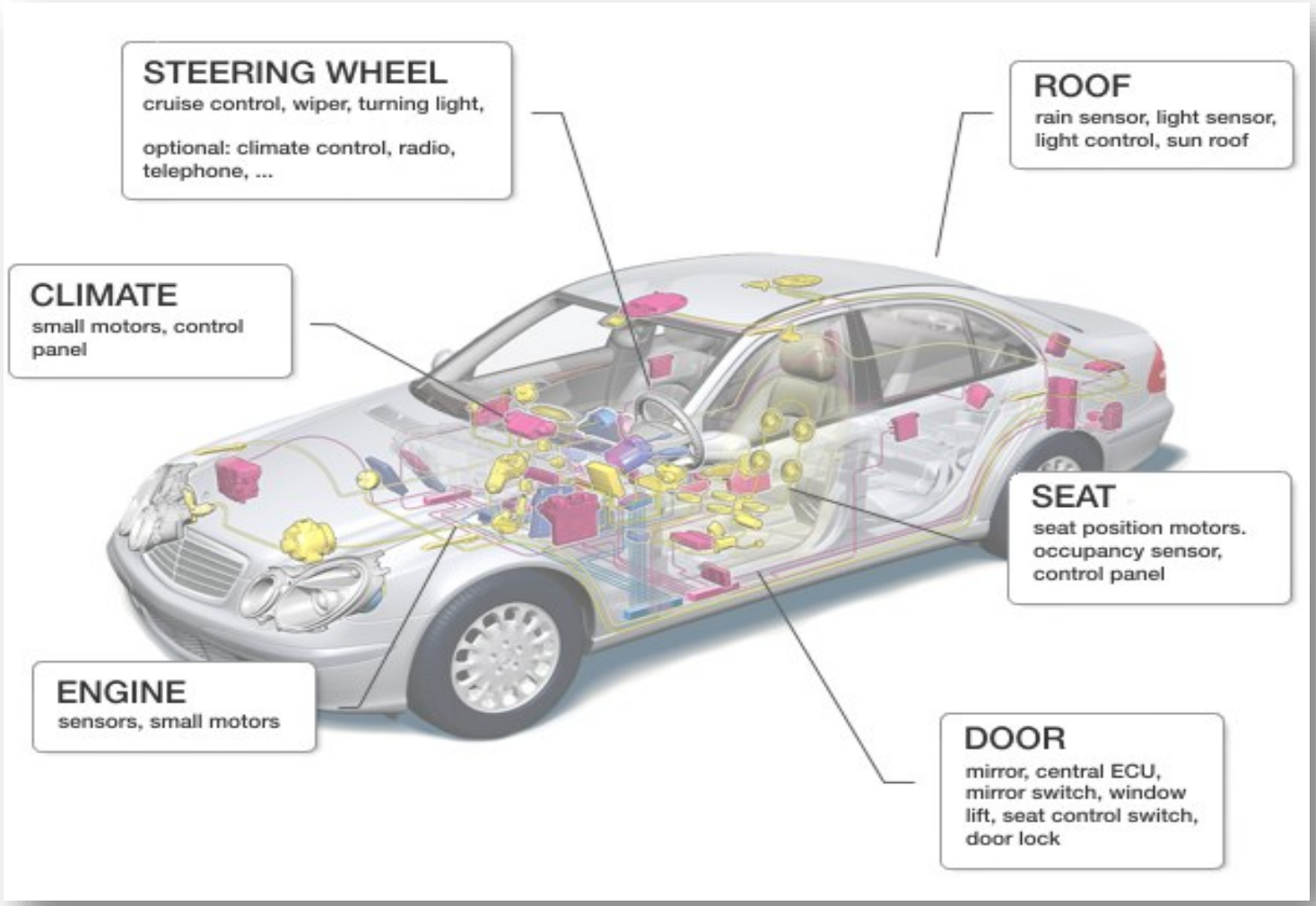


Microelectronic Nose

(Detects & Recognizes gases to save lives)

LIN

local Interconnected is a cost competitive serial communication system designed for localized vehicle electrical network.



Smart Sensor Mobile Phone Holder

Headphones

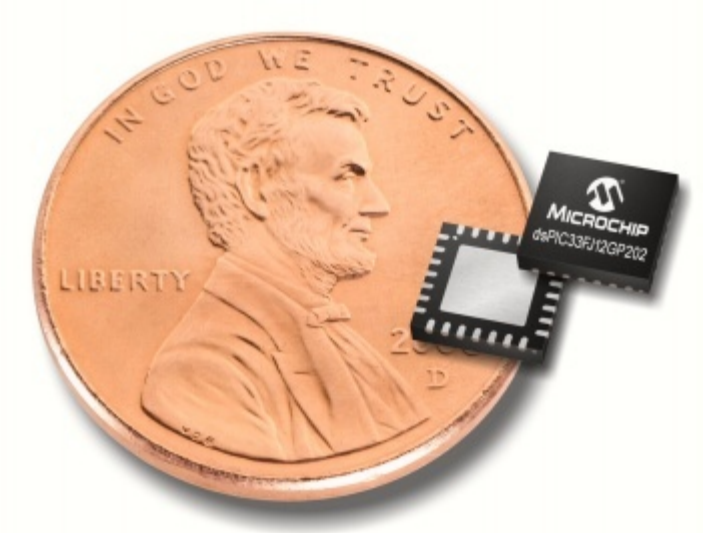
Bluetooth Smart Sensor

Microchip Technology Enables Smart Sensor Applications With New Family of the World's Smallest & Most Cost-Effective DSCs

Microchip Technology Inc. a leading provider of microcontroller and analog semiconductors, today announced the dsPIC33FJ12GP family of Digital Signal Controllers (DSCs), which are uniquely suited for a new class of "Smart Sensor" applications.

Because they are the world's smallest DSCs (in 18- and 28-pin packages as small as 6x6 mm) and the lowest priced (starting at $1.99 each in 10,000-unit quantities), the 40 MIPS dsPIC33FJ12GP family enables a new class of sensor processing, dubbed Smart Sensors, which can enhance sensor performance and extend product life.

Key Features of Microchip DSC



- **40 MIPS performance in 6x6 mm packages**
- **12 Kbytes of Flash and 1 Kbyte of RAM**
- **ADC w/ up to 10 channels, and user-selectable 10-bit or 12-bit mode**
- **1 - UART, 1 - SPI and 1- I^2C Port**

REFERENCES

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www.smartsensorystem.com

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- LIN Administration

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- Design & Reuse
  (D & R Industry Articles)
- Smart Sensor & Application Student Guide
- Smart Sensor User Manual

- **Smart Sensors by Prof. Dayashankar Dubey**

(M.Tech.credit seminar report,Electronic Systems Group, EE Dept, IIT Bombay,submitted November 2002.)

- **Smart Sensor Systems Integration: New Challenges**

  Prof. Sergey Y. Yurish IFSA President, Barcelona, Spain

- **Smart Sensing Technology: Opportunities and Challenges**

  B.F. Spencer, Jr.,1 Manuel E. Ruiz-Sandoval,2 and Narito Kurata3

- **Smart Interfaces for Sensors by James Wiczer**

  Sensor Synergy, Inc.

- **A SMART ARCHITECTURE FOR LOW-LEVEL IMAGE COMPUTING**

  A. ELOUARDI, S. BOUAZIZ, A. DUPRET, L. LACASSAGNE, J.O. KLEIN, AND R. REYNAUD

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Discussion……

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Thanks You